9. (20 points) A ray of light passes from air into a block of glass with a refractive index of 1.50 as shown in the figure (note the drawing isn't to scale). What is the value of the distance D? (CJ 26-9)?

a. 1.42 cm  
b. 1.66 cm  
c. 1.90 cm  
d. 2.14 cm  
e. 2.38 cm

\[ n_1 \sin \theta_1 = n_2 \sin \theta_2 \]

\[ \theta_2 = \sin^{-1} \left( \frac{n_1 \sin \theta}{n_2} \right) \]

\[ = \sin^{-1} \left( \frac{1.60}{1.50} \cdot \sin 50^\circ \right) \]

\[ = 30.7^\circ \]

\[ \tan \theta_2 = \frac{D}{4.00 \text{ cm}} \text{ can use } \sin \theta_2 \text{ or } \cos \theta_2 \text{ with hypotenuse as well} \]

\[ D = 4.00 \text{ cm} \cdot \tan(30.7^\circ) = 2.38 \text{ cm} \]

10. (20 points) In a Young's double-slit experiment, a thin sheet of mica is placed over one of the two slits. As a result, the center of the fringe pattern (on the screen) shifts by an amount corresponding to 30 dark bands. The wavelength of the light in this experiment is 480 nm and the index of refraction of the mica is 1.60. The mica thickness (in \( \mu \text{m} \)) is: (HRK 45-16)

a. 90  
b. 12  
c. 14  
d. 24  
e. 62

originally path difference is \((m+\frac{1}{2})\lambda = 30.5 \lambda \text{ (or } d \sin \theta)\)

after mica in place the light through mica has \( \frac{t}{\lambda} = \frac{t}{\lambda} \text{ wavelengths inside while at the same time, the light that doesn't go through mica has } \frac{t}{\lambda} \text{ wavelengths} : \text{ so the path difference is } \left( \frac{t}{\lambda} - \frac{t}{\lambda} \right) \lambda \text{ which is equal to first path difference } \)

\[ \frac{(n+\frac{1}{2})\lambda}{\lambda} = 30.5 \lambda \]

\[ t \cdot (n+1) = 30.5 \lambda \]

\[ t = \frac{30.5 \lambda}{n+1} = \frac{(30.5)(480 \times 10^{-9} \text{ m})}{1.6 - 1.0} \approx 2.4 \times 10^{-5} \text{ m} \]